

Methods of Plant Propagation: Sexual & Vegetative

Swaraj Meher, Priya Sagar, Smile Sandal

M.Sc. Agriculture (Hons.-Agronomy), Sri Dev Suman Uttarakhand University, Chamba, Uttarakhand, India

ABSTRACT

The fruit plants are propagated by two main methods, namely, sexual method and asexual method. Most of the fruit plants do not produce seedlings true-to-type. Using the asexual method of propagation the fruit plants produce true-to-type (clones) of the parent plant. Moreover, these plants also produce uniform yield, fruit size and quality. Although seedling plants produce heavy crop, the fruit size and quality is inferior and do not fetch good return in market. The seedling plants for several fruit crops have long juvenile period and have more vigorous growth habit, which creates difficulty in taking plant protection measures and harvesting of fruits. The fruits of seedling plants do not mature in one stroke and hence, affect the marketing. The asexual methods of plant propagation are of the four types, Cutting, Layering, Budding and Grafting. In this communication we present review on the Sexual method of propagation (Seed) along with all the asexual or vegetative methods like, Cutting, Layering, Budding and Grafting methods of plant propagation. The cutting method includes root, stem, scion and leaf cutting methods of vegetative propagation. The layering method category encompasses the Natural, Simple, Tip, Compound or Serpentine, Trench, Mound and Air layering methods. The budding method of the asexual propagation includes, T/Shield, Inverted T/Shield, Chip, I, Patch, Forkert, Flute and Ring/ Annular Budding methods.

KEYWORDS: Sexual propagation (seed), Vegetative Propagation, Cutting, Budding, Grafting, Layering

INTRODUCTION:

Most of the horticultural plants can be propagated by two means. Namely, Sexual propagation (seed) and Asexual/Vegetative propagation. Sexual reproduction of fruit trees is a rarely used method in horticulture. Mainly applied in research stations to conserve the richness of the gene pool and develop new varieties. On the production side, this method cannot satisfy the requirements for production quality and quantity. The new specimen, resulted from the sexual reproduction, carries unpredictable characteristics of its own, which includes the tendency to revert to a wild-like state of the specie. However, some of the known fruits keep intact their specific characteristics of the variety independently from the way, which was used for propagation. It can be sexual or asexual reproduction these fruits inherit the characteristics of the variety.

Plant can be asexually reproduced either by using part of two or more plants in a union or parts of the same plant. In the first case we call it graft age and in the second case we call it rooting. All asexual propagation techniques belong one of the two categories. Most of the fruit plants do not produce seedlings true-to-type. This problem can be overcome by using the asexual method of propagation as these fruit plants produce true-to-type (clones) of the parent. Moreover, these plants also produce uniform yield, fruit size and quality. Although seedling plants produce heavy crop, the fruit size and quality is inferior and do not fetch good return in market. The seedling plants for several fruit crops have long

juvenile period and have more vigorous growth habit, which creates difficulty in taking plant protection measures and harvesting of fruits. The fruits of seedling plants do not mature in one stroke and hence, affect the marketing. Keeping these disadvantages of seedling plants in mind and to obtain uniformity in plant performance, fruit plants should be propagated through asexual methods of propagation. The asexual methods of plant propagation can mainly be divided into four groups, namely, (i) Cutting, (ii) Layering, (iii) Budding and (iv) Grafting.

➤ CUTTING

A plant cutting is a piece of a plant that is used in horticulture for vegetative (asexual) propagation. A piece of the stem or root of the source plant is placed in a suitable medium such as moist soil. If the conditions are suitable, the plant piece will begin to grow as a new plant independent of the parent, a process known as striking. A stem cutting produces new roots, and a root cutting produces new stems. Some plants can be grown from leaf pieces, called leaf cuttings, which produce both stems and roots. The scions used in grafting are also called cuttings. Some plants form roots much more easily than others. Softwood cuttings are used for stems that are rapidly expanding, with young leaves. Semi-hardwood cuttings are used for stems that have completed elongation growth and have mature leaves. Hardwood cuttings are used for fully matured stems, and are often propagated while dormant.

How to cite this paper: Swaraj Meher | Priya Sagar | Smile Sandal "Methods of Plant Propagation: Sexual & Vegetative"

Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-4, June 2021, pp.1117-1124,

URL: www.ijtsrd.com/papers/ijtsrd42533.pdf



IJTSRD42533

Copyright © 2021 by author (s) and International Journal of Trend in Scientific Research and Development Journal. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0) (<http://creativecommons.org/licenses/by/4.0>)



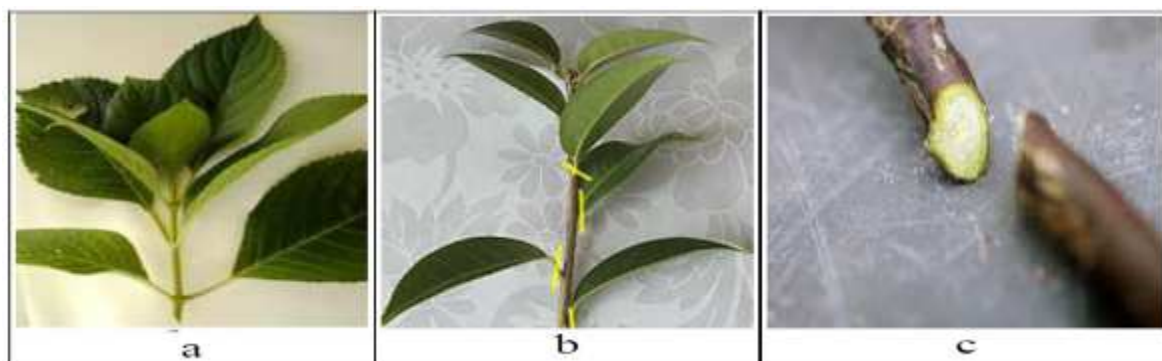


Fig: a-Soft, b-semi-hard and c-hard woods

Most plant cuttings are stem pieces, and have no root system of their own; they are likely to die from dehydration if the proper conditions are not met. They require a moist medium, which, however, cannot be too wet lest the cutting rot. A number of media are used in this process, including but not limited to soil perlite, vermiculite, coir, rock wool, expanded clay pellets, and even water given the right conditions. Most succulent cuttings can be left in open air until the cut surface dries, which may improve root formation when the cutting is later planted.

Stem cuttings of young wood should be taken in spring from the upper branches, while cuttings of hardened wood should be taken in winter from the lower branches. Common bounds on the length of stem cuttings are between 5-15 cm for the soft-wood and 20-25 cm for the hard-wood. The soft-wood cuttings do the best when about two thirds of the foliage is removed, while the hard-wood stem cuttings need complete foliage removal.

The environment for cuttings is generally kept humid—often attained by placing the cuttings under a plastic sheet or in another confined space where the air can be kept moist—and partial shade to prevent the cutting from drying out. Cuttings in the medium are typically watered with a fine mist to avoid disturbing plants. A rooting hormone may be administered to encourage growth and can increase the success rate of plant growth.

Many vegetative parts of a plant can be used. The most common methods are:

1. Root cuttings, in which a section of root is buried just below the soil surface, and produces new shoots.
2. Stem cuttings, in which a piece of stem is part buried in the soil, including at least one leaf node. The cutting is able to produce new roots, usually at the node.
3. Scion cuttings are used in grafting.
4. Leaf cuttings, in which a leaf is placed on moist soil. These have to develop both new stems and new roots. Some leaves will produce one plant at the base of the leaf. In some species, multiple new plants can be produced at many places on one leaf, and these can be induced by cutting the leaf veins.

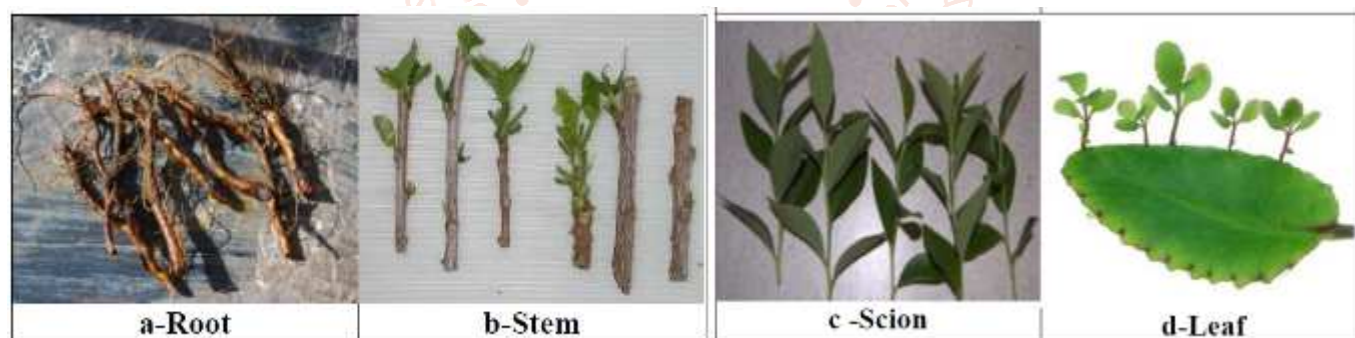


Fig: Plant Cuttings

➤ LAYERING

Layering is a common plant vegetative propagation technique in natural environments where an aerial stem is made to grow roots prior to detachment from the parent plant. Natural layering occurs when a branch comes in contact with the ground and spontaneously grows adventitious roots. At a later stage the connection with the parent plant is severed and as a result a new plant is produced. Layering has the advantage over the cutting that the propagated portion continues to receive water and nutrients from the parent plant while it is forming roots. Layering is also utilized by horticulturists to propagate desirable plants. The horticultural layering process typically involves wounding the target region to expose the inner stem and optionally applying rooting compounds. As layering does not involve sexual reproduction, new plants are effectively clones of the original plant and exhibit the same characteristics.

The plant layering is mainly of the following types:

(i) Natural layering, (ii) Simple layering, (iii) Tip layering, (iv) Compound or Serpentine layering, (v) Trench layering, (vi) Mound layering, (vii) Air layering.

I. Natural Layering

Sometimes layering occurs naturally, without the assistance of a propagator. Runners and offsets are specialized plant structures that facilitate propagation by layering. A runner produces new shoots where it touches the growing medium. Examples include strawberry and spider plant.

Plants with rosette stems often reproduce by forming new shoots, called offshoots, at their base or in the leaf axles. Examples include date palm, bromeliads, and many cacti.

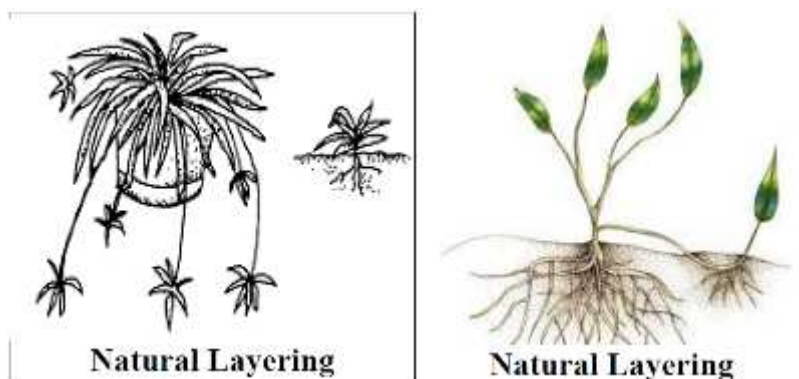


Fig: Natural Layering

II. Simple / Ground Layering

Simple layering can be accomplished by bending a low growing, flexible stem to the ground. Part of the stem is covered with soil, leaving the remaining 6 to 12 inches above the soil. The tip is bent into a vertical position and staked in place. Simple layering can be done on most plants with low-growing branches. The most common example of plant propagated by simple layering includes climbing roses.

Simple layering can be done in early spring using a dormant branch, or in late summer using a mature branch. Periodically the adequate moisture level and the formation of roots are checked. It may take one or more seasons before the layer is ready to be removed for transplanting.

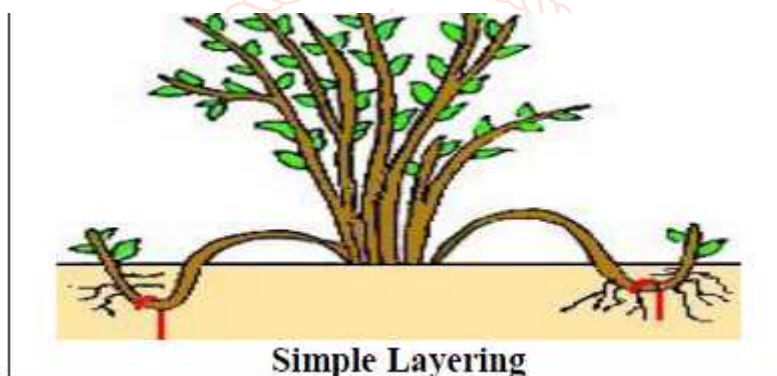


Fig: Simple Layering

III. Tip Layering

Tip layering is quite similar to simple layering. Tip layering works by pushing the very tip or point of a stem underground and holding it in place with a pin. A hole is dug 3 - 4 inches deep in the soil. The tip of a shoot of the current season is inserted in and covered with the soil. The tip grows downward first, then bends sharply and grows upward. Roots form at the bend. The recurved tip becomes a new plant.

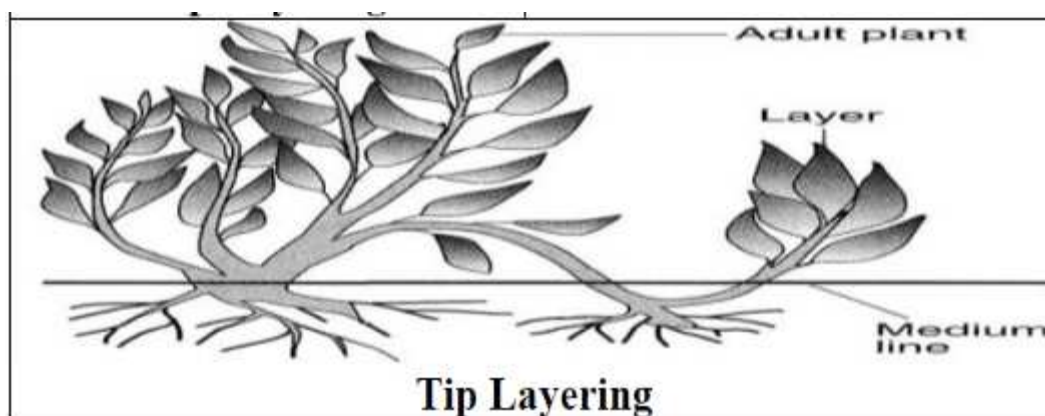


Fig: Tip Layering

IV. Compound / Serpentine Layering

Compound / Serpentine Layering is similar to simple layering, but several layers are made from a single stem. The stem is bent to the rooting medium as for simple layering, but alternately covering and exposing the sections of the stem. Each section should have at least one bud exposed and one bud covered with soil.



Fig: Compound Layering

V. Trench / Etiolation Layering

Trench / Etiolation layering is primarily used for fruit trees which are difficult to propagate by other methods, and works best with plants whose buds will break and grow under the soil, such as willows, grapes.

In this method the parent plant is planted at an angle of 30-40 ° to the ground so that branches may be pulled down to the soil surface more easily. A young, vigorous branch is laid horizontally in a 5 cm trench and pegged into position. It is then covered with soil to encourage the development of several new shoots. As these shoots develop, soil is filled around them and roots eventually develop. The rooted shoots can then be detached from the original branch and planted out.

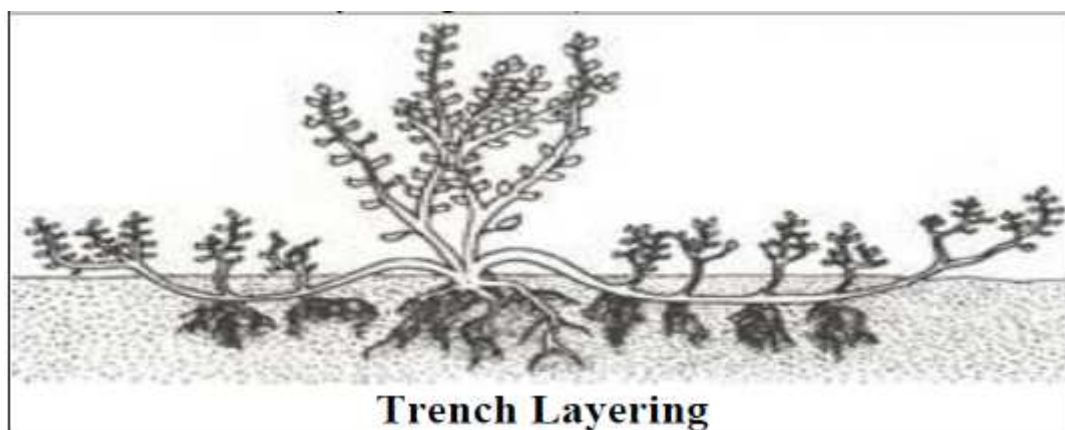


Fig: Trench Layering

VI. Mound / Stool Layering

Mound layering is a vegetative propagation technique in which the original plants are set in the ground with the stem nearly horizontal, which forces side buds to grow upward. After these are started, the original stem is buried up to some distance from the tip. At the end of the growing season, the side branches are rooted, and can be separated while the plant is dormant.

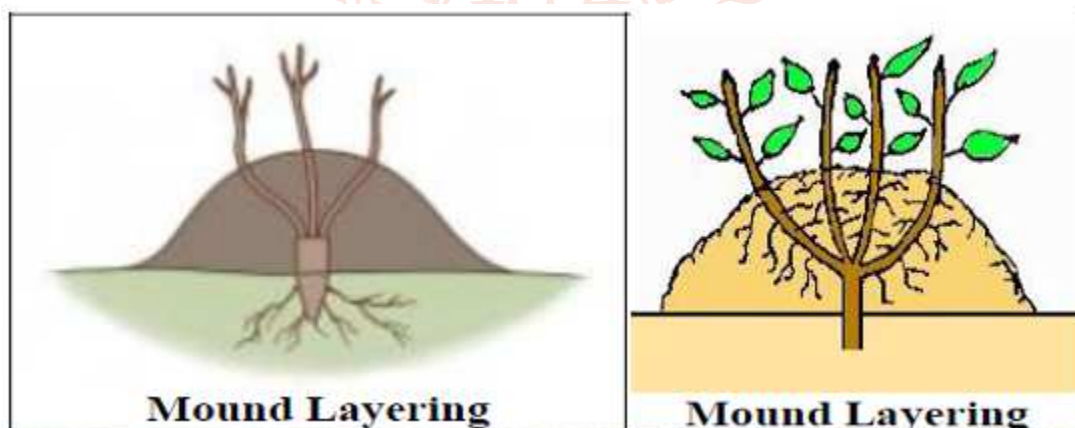


Fig: Mound Layering

VII. Air layering

Air layering can be used to propagate large, overgrown house plants such as rubber plant, croton, or dieffenbachia that have lost most of their lower leaves. Woody ornamentals such as azalea, camellia, magnolia, oleander, and holly can also be propagated by air layering. Air layering is done by peeling the bark from the middle of a branch and covering this exposed wood with moss and plastic wrap. Roots will form inside the moss, and one can cut the rooted tip from the plant. For optimum rooting, air layers are made in the spring on shoots produced during the previous season or in mid to late summer on shoots from the current season's growth.

For monocots, an upward 2.5- 4.0 cm cut is made about one-third through the stem. The cut is held open with a toothpick or wooden match stick. The wound is surrounded with moist, unmilled sphagnum moss (about a handful) that has soaked in water and squeezed to remove excess moisture. The moss is wrapped with plastic and held in place with twist ties or

electrician's tape. Each end of the plastic is fastened securely, to retain moisture and to prevent water from entering. If exposed to the sun, the plastic should be covered. Aluminum foil can also be used, as it does not require twist ties or tape to hold it in place.

The process for dicots is similar, except a 2.5 cm ring of bark is removed from the stem. With a sharp knife, two parallel cuts are made about 2.5 cm apart around the stem and through the bark and cambium layer. The two parallel cuts are connected with one long cut. The ring of the bark is removed, leaving the inner woody tissue exposed. The newly bared ring is scraped to remove the cambial tissue to prevent a bridge of callus tissue from forming. Application of a root-promoting substance to the exposed wound is sometimes beneficial.



Fig: Air Layering

➤ BUDDING

Budding is a type of asexual reproduction in which a new plant develops from an outgrowth or bud due to cell division at one particular site. The method of budding is the most common technique for plant propagation in commercial nurseries. First, one must graft a single bud attached to the stem of the rootstock. The stem or branch may not be thicker than 2 cm diameter. Therefore, this method is only applicable for young rootstock plants or smaller branches of large plants.

I. T Budding or Shield Budding

T-Budding or Shield Budding is a special grafting technique in which the scion piece is reduced to a single bud. Successful T budding requires that the scion material have fully-formed, mature, dormant buds, and that the rootstock be in a condition of active growth such that the *bark is slipping*, i.e., the vascular cambium is actively growing, and the bark can be peeled easily from the stock piece with little damage. T budding can be performed on certain fruit trees.

Plant the rootstock in autumn, about 30cm apart, in nursery beds. If the weather is dry, water the rootstocks for two weeks beforehand to ensure that the bark will lift easily; this is crucial for success. For the bud wood, select strong-growing ripened shoots. Cut away a healthy bud with a strip of bark extending about 2.5cm above and below the bud. Carefully pull away the woody material from behind the bud. Cut the rootstock just deeply enough to pierce the bark and make a T-shaped incision at a height of 15-30 cm from the base, with the horizontal cut about 13mm long and the vertical cut 2-4cm long. Ease the flaps of the T outwards to reveal the cambium layer (green wood) beneath. Insert the bud behind the bark flaps with the bud just below the cross-stroke of the T. Trim away the surplus tail protruding above T. Secure the bud using a rubber binding tie or damp raffia around the grafted area. When the shoot develops the following spring cut off the growth above the bud.

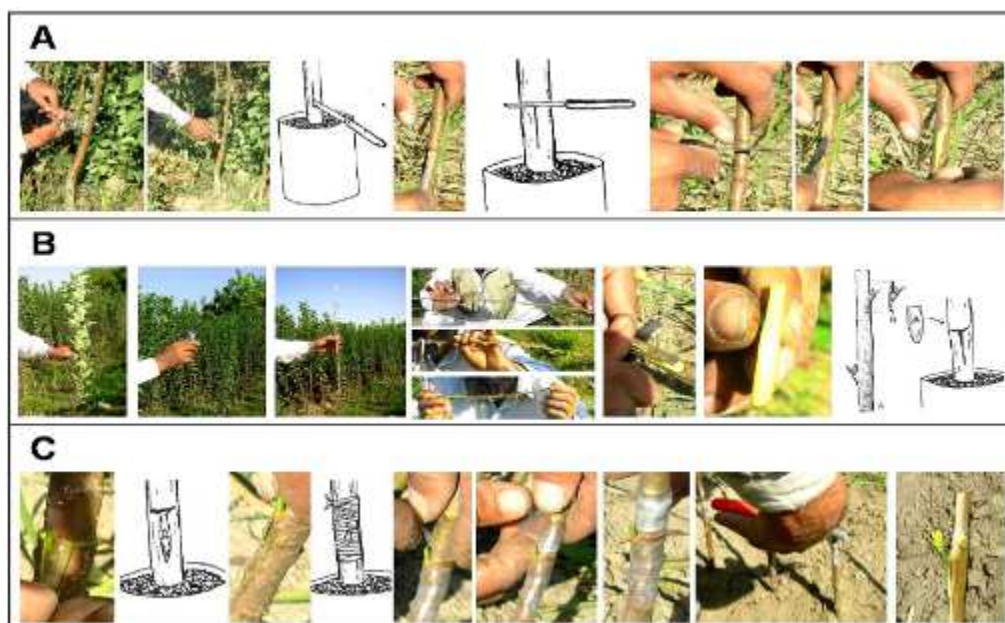


Fig: T-Budding

II. Inverted T-Budding

The inverted T-budding technique is exactly same as the normal T-budding method with the exception that the horizontal cut is made on the bottom end of the incision. In this case, the bud is cut from the bud stick by starting above the bud and exiting below it. Currently most fruit trees are propagated with the T-budding method. However, the use of inverted T-budding technique is much more effective due to the downward flow of hormones that are intercepted below the bud. Therefore, the union will be stronger and the healing process will be faster (as opposed to the normal T-budding method. This method of budding is used to prevent the possible entry of water from the top of the T-cut which may cause rotting of the shield piece.

III. I – Budding

A method of budding in which incisions in the shape of an I (capital of letter i) is made in the bark of the rootstock by a single vertical cut and a horizontal cross-cuts at both the ends, is called I budding. A rectangular bud patch similar to that in patch budding is then inserted in I cut.

IV. Patch Budding

Patch budding is probably the simplest to perform amongst the various methods of budding due to ease in removing or preparing rectangular patches of the bark. It is widely used in plants with thick bark that can be easily separated from the wood. The method involves the complete removal of a rectangle-shaped patch of bark with the longer sides parallel to the axis of the stem of the rootstock. It is then replaced with a bud patch of the same size from a bud stick.

The patch of the bud is cut from both the rootstock and the bud stick by two parallel horizontal cuts either with one stroke of a double-bladed knife or two strokes when using a single-bladed knife. With vertical stroke of a knife, both horizontal cuts are connected at each side. The bud patch is carefully removed intact and inserted into the rootstock.



Fig: Patch Budding

V. Flute Budding

Flute budding is similar to patch budding but the patch of bark that is removed from the stem of a rootstock almost completely encircles it except that there remains a narrow strip of bark (~1/8 the rootstock circumference) that connects the upper and the lower parts of the rootstock. The bud patch is prepared by two horizontal cuts about 2.5 cm apart (the same length as in the rootstock) in circular motion around the stem. The two cuts are then connected by a vertical cut and the patch of bark is separated intact from the wood. The circumference of the bud patch may be shortened by a vertical cut to fit into the rootstock.

VI. Ring or Annular Budding

In this method of budding the procedure is closely similar to the Flute budding. It involves the removal of a complete ring of bark from the rootstock without leaving a strip of bark that connects the upper and lower parts of the rootstock. As a result, a portion of the stem is girdled as if in preparation for marcotting. It is then replaced with a complete ring of bark with the same size from the bud stick. Compared to the other methods of budding, it is rarely used because should bud union fail, the upper part of the rootstock above the ring may die.

VII. Chip-budding

Chip-budding does not use the protective bark flaps as T-budding does, but it also does not use slipping bark. The first step is to make a cut about 2-2.5 cm long with a depth of $\frac{1}{4}$ to $\frac{1}{5}$ the diameter of the stock. With a horizontal cut made on the bottom, the cutting can be removed. The bud can also be cut off if necessary. The bud stick and stock must be the same diameter. The stock and scion must be placed together in such a way that allows the cambia of the bud and stock to match together as much as possible. Desiccation is a high risk when we use this method, therefore, the wound should be wrapped tightly with grafting tape.

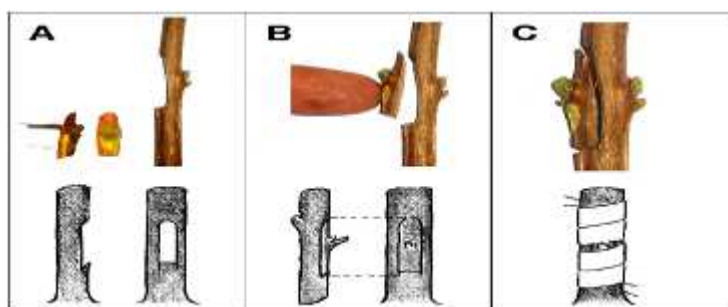


Fig: Chip Budding

➤ GRAFTING

Two types of rootstock can be used for grafting: the cultivar and the seedling rootstock. The cultivar rootstock is produced by vegetative methods, generally by layering and cuttings. Seedling rootstocks grow from seed. One of the best examples for cultivar rootstock is the apple and for the seedling rootstock, the mango.

There are some rules, which must be taken consideration for any grafting method to be successful:

- Two incompatible plants cannot be grafted.
- The cambium layers of the rootstock and the scion must touch.
- The scion must be the right way up when grafting is done.
- Grafting can be performed in any time of the year, but the best time for deciduous plants is, when the plant drops its leaves and is dormant.
- Cool, cloudy day without wind prevents the graft from drying out, therefore this type of weather is the best for grafting.
- The care activities are very important until the rootstock and scion are properly joined.

I. Whip Grafting

The whip graft is useful for plants that unite easily. This method is useful for apples, mangos and pears. It can be used to graft root, stem or top graft. The diameter of the scion and rootstock should be the same, from the size of a pencil to 10-15 mm.

A. Simple Whip Grafting

This type of grafting practice includes the process of a simple sloping cut on both the scion and the rootstock. The two parts should overlap each other perfectly. In any case, one rule must be followed: The wider the scion and root stock, the longer the cut surface.

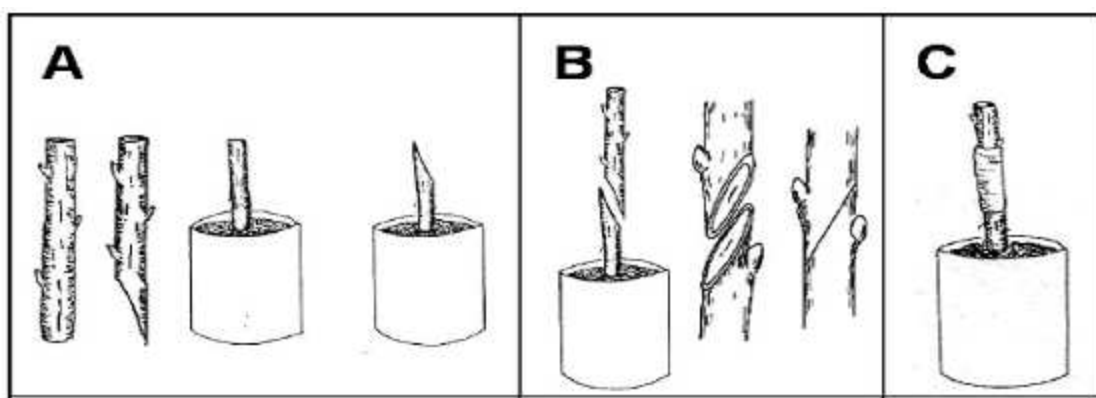


Fig: Simple whip grafting

B. English (Tongue) Whip Grafting

This method is more common in practice, especially in the case of pear and apple trees. It is used to graft thin stems. It may be used on roots, stems or tops. The scion should have two or three buds with the graft made below the bottom bud. The first cut is a 2-5 cm sloping cut at the bottom of the scion. The second cut is made with a distance 1/3cm from the tip of the first cut. The same process is repeated on the rootstock. In apple propagation, the tongue grafting is mainly used to graft on M4 (semi-dwarfing – 5m height) and M9 (very dwarfing – 3m height) rootstock.



Fig: English (Tongue) whip grafting

C. Cleft Grafting

This method has been practiced throughout the history of horticulture and is one of the oldest fruit propagation techniques. It is suited for apple and pears, but, in tropical areas, it can also be used for propagation of mango and avocado trees. Citrus and guava trees also use this method. In the case of top and side work, the scaffold limb is usually wider than the scion. In the case of tree propagation, both parts, the rootstock and scion, should be the same size.

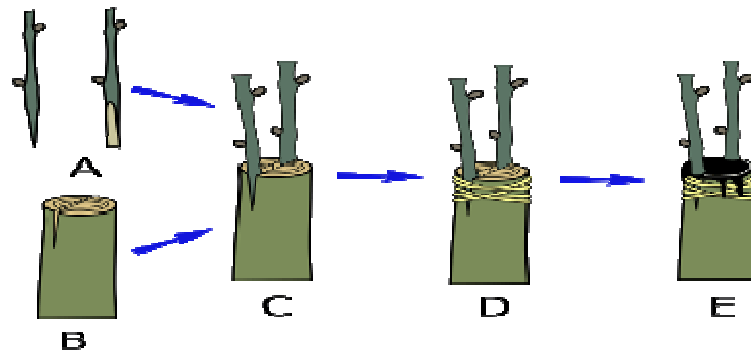


Fig: Cleft Grafting

II. Bark Grafting

Bark grafting is used when the stock is too large for whip grafting. It is one of the most difficult grafting techniques. Perfect application of this method requires much practice and experience. The use of this technique is common for pear, apple and different nuts grafting.

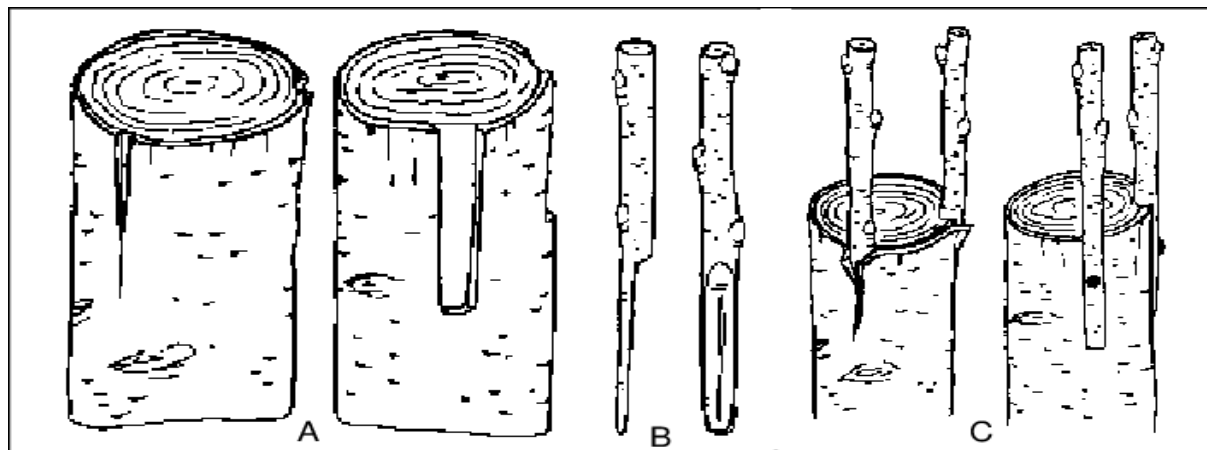


Fig: Bark grafting

REFERENCES

- [1] Cutting (plant) - Wikipedia; Link: [https://en.wikipedia.org/wiki/Cutting_\(plant\)](https://en.wikipedia.org/wiki/Cutting_(plant)) and references cited therein.
- [2] Layering - Wikipedia; Link: <https://en.wikipedia.org/wiki/Layering> and references cited therein.
- [3] Methods of Budding in Plant Propagation - Crop Farming; Link: www.cropsreview.com/methods-of-budding.html
- [4] Techniques of Budding - Aggie Horticulture Link: https://aggiehorticulture.tamu.edu/faculty/davies/.../M13_DAVI4493_08_SE_C13.pd...
- [5] Grafting and Budding Nursery Crop Plants | NC State Extension. Link: <https://content.ces.ncsu.edu/grafting-and-budding-nursery-crop-plants>
- [6] Hartmann HT, Kester DE. Plant Propagation: Principles and Practices. 3rd ed.. New Jersey: Prentice Hall Inc. 1975, 428-454.
- [7] Verheij EWM, Coronel RE, eds. Edible Fruits and Nuts. Plant Resources of South-East Asia No. 2. Bogor, Indonesia: Prosea Foundation. 1992, 392.
- [8] Grafting, Budding. Nursery Crop Plants. ces. ncsu. edu. North Carolina Cooperative Extension Service, North Carolina State University, College of Agriculture and Life Sciences. Nd. Web. 2014.